PATENT ABSTRACTS OF JAPAN

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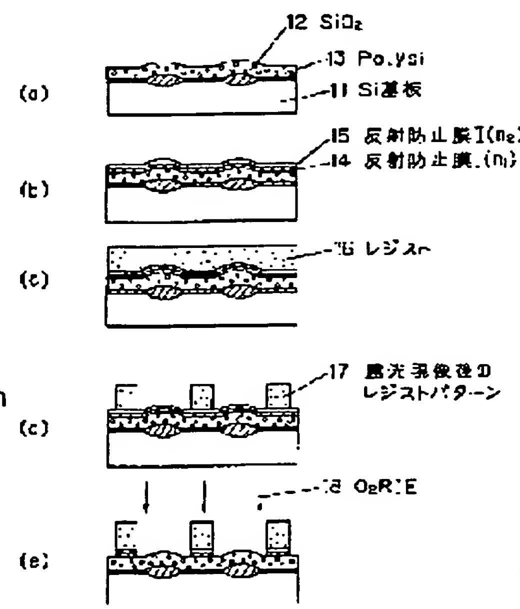
(54) FORMATION OF FINE PATTERN

(57)Abstract:
PURPOSE: To achieve sufficient antireflection effect by depositing more than one kind of multilayer antireflection film on a high reflectinity semiconductor substrate having irregularities, and after exposing and developing a resist applied thereon, removing a multilayer reflective film by dry etching.
CONSTITUTION: More than one kind of multilayer antireflection films 14, 15 are deposited on a high reflecting semiconductor substrate 1 having irregularities by plasma CVD. The films 14, 15 are coated with a chemical amplification resist 16 which is then exposed by a KrF excimer laser stepper. It is then developed with a TMAH solution and the multilayer antireflection films 14, 15 are removed by reactive etching 18. Consequently, a pattern can be formed with high controllability with no influence of reflection on the underlying layer regardless of some fluctuation in the thickness of the films 14, 15 and sufficient antireflection effect is achieved regardless of some fluctuation in the thickness thereof.



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CLAIMS

[Claim(s)]
[Claim 1] high -- the detailed pattern formation approach equipped with the process which deposits at least two or more kinds of multilayer acid-resisting thin films in plasma CVD on the semi-conductor substrate which has reflection factor irregularity, the process which applies a resist on said reflective thin film, and the process which removes said multilayer reflective film for said resist by dry etching after exposure development.
[Claim 2] The detailed pattern formation approach according to claim 1 that at least one or more acid-resisting thin films are characterized by consisting of polymers of a fluorine system among the multilayer reflective thin film film deposited in plasma CVD.
[Claim 3] The detailed pattern formation approach according to claim 1 by which it is characterized [which is characterized by removing a multilayer antireflection film on the same dry etching conditions].
[Claim 4] The detailed pattern formation approach according to claim 1 by which it is characterized [which is characterized by removing the multilayer antireflection film on separate dry etching conditions].
[Claim 5] The detailed pattern formation approach according to claim 1 characterized by the refractive indexes of a multilayer antireflection film differing.
[Claim 6] high -- the detailed pattern formation approach equipped with the process which carries out the mixed deposition of the organic polymer which has at least two or more kinds of refractive indexes on the semi-conductor substrate which has reflection factor irregularity by plasma CVD, the process which applies a resist on said reflective thin film, and the process which removes said resist by the exposure development back, and removes said mixed antireflection film by dry etching.
[Claim 7] high -- the detailed pattern formation approach equipped with the process which deposits the acid-resisting thin film which has photosensitivity to exposure light in plasma CVD on the semi-conductor substrate which has reflection factor irregularity, the process which applies a resist on said reflective thin film, and the process which forms a detailed pattern by carrying out exposure development of said resist and the CVD antireflection film simultaneously.

[Claim 8] high -- the detailed pattern-formation approach equipped with the process which deposits the acid-resisting thin film which has photosensitivity in plasma CVD on the semi-conductor substrate which has reflection factor irregularity, the process which apply a resist on said reflective thin film, and the process which form a detailed pattern by carrying out exposure development of the antireflection film with the exposure light of wavelength which is different

from the exposure light to said resist film after exposure development in said resist film.
[Claim 9] The detailed pattern formation approach according to claim 7 characterized by exposing the antireflection film of a wafer periphery with a wafer circumference exposure machine, and removing in development.
[Claim 10] high -- the detailed pattern-formation approach equipped with the process which applies a resist on the process which applies at least 1 microns or more of acid-resisting thin films of the organic polymer which has photosensitivity on a spin coat on the semi-conductor substrate which has reflection factor irregularity, and the antireflection film which became the thickness of said request after exposure development so that it might become the thickness of a request of said reflective thin film, and the process which carry out the exposure development of said resist film with exposure light.
[Claim 11] high -- the detailed pattern-formation approach equipped with the process which applies a resist on the process which applies at least 1 microns or more of acid-resisting thin films of an organic polymer on a spin coat on the semi-conductor substrate which has reflection factor irregularity, and the antireflection film which became the thickness of said request after dry etching so that it might become the thickness of a request of said acid-resisting thin film, and the process which carries out exposure development of said resist film with exposure light.

[Translation done.]

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the formation approach of of the semiconductor device and integrated-circuit pattern using a photolithography to a semi-conductor substrate top with a high reflection factor.
[0002]
[Description of the Prior Art] In recent years, pattern formation is performed in manufacture of semiconductor devices, such as IC and LSI, an electronic-circuitry component, etc. by the photolithography using ultraviolet rays. Although a raise in the numerical aperture of the projection lens of the aligner currently use in this photolithography, the activity of the source of short wave Nagamitsu, etc. be advance with detailed-izing of a component in recent years, and high integration, the problem of the standing wave effectiveness that the reflection factor from substrate-izing become high, and the effect of the standing wave in the inside of the resist film of exposure light become large, and fluctuation of a pattern dimension become large by it etc. arise. The energy accumulated by the cross protection of the light of an echo of the resist front face of exposure light and the echo from a substrate interface into the resist film is the thing of effectiveness which changes with minute change of resist thickness a lot, and the standing wave effectiveness is the phenomenon of changing a pattern dimension sharply by it.
[0003] Especially, these faults have the reflexibility remarkable in a high substrate over exposure light. For example, in the aluminum film and polish recon film which have irregularity in a substrate front face, the resist pattern itself becomes rickety by the scattered reflection from the substrate of exposure light. The approach using the resist containing a die which made the color which absorbs exposure light in a resist contain as an approach of controlling these faults, and the approach which has formed enough an antireflection film which absorbs exposure light on the substrate which has the high reflection factor which is a substrate, and carries out it were used. Moreover, the multilayer-resist process was proposed as other approaches.
[0004] The explanatory view of a three-layer resist is shown in drawing 8 . On the polish recon substrate which a reflection factor is high and has irregularity in a front face, it heat-treats by carrying out the 2-micron thickness spin coat of the poly membrane 81 which controls the reflected light from a substrate (this drawing a). Besides, 0.2-micron thickness formation of the inorganic polymer film 82, such as inorganic film of SiO2 grade or SOG (spin-on glass), is carried out as an interlayer. Furthermore, 0.5-micron thickness spreading of the photoresists, such as AZ micro POJITTO (Shipley), is carried out as an upper resist 83 on this, and a semiconductor integrated circuit pattern is exposed with a cutback projection aligner (this drawing b). Then, negatives are developed using an alkali water solution and the desired resist pattern 84 is formed (this drawing c). Next, a pattern imprint is performed more on the middle class 82 and the lower layer film 81 dirtily in a businesslike manner by using this resist pattern 84 as a mask (these drawings d and e). And pattern formation is carried out to the polish recon film 13 by dry etching using the pattern formed by doing in this way, and gate pattern formation is performed.
[0005] Since the lower layer film 81 which absorbs the reflected light from a substrate is formed on a high reflective substrate like the polish recon 13 by using the above multilayers resist, a substrate echo is controlled and the exact upper pattern is obtained.
[0006]
[Problem(s) to be Solved by the Invention] However, although a three-layer resist process is an effective approach, its process is complicated and there are problems, such as fluctuation of a resist dimension, at the time of a pattern imprint. Moreover, a defect and dust generating

become large and pose a big problem of yield lowering. Moreover, although an echo can be controlled by paying a color into a resist by the resist containing a die which made the color contain, since the incidence of exposure light will be barred simultaneously, there is a fault said that resolution deteriorates. Moreover, if pattern formation is performed on antireflection film which absorbs exposure light on the substrate which has a high reflection factor, it is dramatically difficult for the reflection factor from a substrate to fall, and for a taper to occur in the cross-section configuration of a resist pattern, to become a trapezoid or 3 angle configuration, and to obtain exact and detailed pattern formation. Furthermore, it had the trouble to say that the etching process of dedication was needed, the pattern shift at the time of etching became large, or the exfoliation process of an antireflection film was needed. If a level difference is furthermore on a substrate, antireflection film thickness will change locally. Therefore, the substrate reflection factor fluctuation accompanying thickness fluctuation arose, and there was a problem that a detailed pattern could not form in accuracy.
[0007] This invention offers the detailed pattern formation approach that sufficient acid-resisting effectiveness can be acquired, even if thickness change of the acid-resisting thin film deposited on the semi-conductor substrate arises somewhat in view of the above-mentioned trouble.
[0008]
[Means for Solving the Problem] in order to solve the above-mentioned trouble -- the detailed pattern formation approach of this invention, high -- at least two or more kinds of multilayer acid-resisting thin films are deposited in plasma CVD on the semi-conductor substrate which has reflection factor irregularity, a resist is applied on said reflective thin film, and a detailed pattern is formed by removing said multilayer reflective film for said resist by dry etching after exposure development.
[0009] furthermore, this invention -- high -- on the semi-conductor substrate which has reflection factor irregularity, the mixed deposition of the organic polymer which has at least two or more kinds of refractive indexes is carried out by plasma CVD, a resist is applied on the thin film, and a detailed pattern is formed more for said resist after exposure development that dry etching removes said mixed antireflection film.
[0010] furthermore, this invention -- high -- the acid-resisting thin film which also has photosensitivity to exposure light is deposited in plasma CVD on the semi-conductor substrate which has reflection factor irregularity, a resist is applied on said reflective thin film, and a detailed pattern is formed by developing said resist and a CVD antireflection film simultaneously.

[0011] furthermore, this invention -- high -- the acid-resisting thin film which has photosensitivity is deposited in plasma CVD on the semi-conductor substrate which has reflection factor irregularity, a resist is applied on said reflective thin film, and a detailed pattern is formed by carrying out exposure development of the antireflection film with the exposure light of wavelength which is different from the exposure light to said resist film after exposure development with exposure light in said resist film.
[0012] furthermore, this invention -- high -- at least 1 microns or more of organic polymer acid-resisting thin films which have photosensitivity are applied on a spin coat on the semi-conductor substrate which has reflection factor irregularity, a resist is applied after exposure development on the antireflection film which became the thickness of said request so that it may become the thickness of a request of said reflective thin film, and it has the configuration which carries out exposure development of said resist film with exposure light and to say.

[0013]
[Function] By the above-mentioned configuration, this invention can acquire sufficient acid-resisting effectiveness, even if thickness change of the acid-resisting thin film deposited on the semi-conductor substrate arises somewhat, and as a result, it can form a detailed pattern with a sufficient controllability.
[0014]
[Example]
(Example 1) The detailed pattern formation approach of the 1st example of this invention is explained below, referring to a drawing.
[0015] Drawing 2 shows the outline of the plasma-CVD equipment used for deposition of the acid-resisting thin film used by this example. In in the glass bell jar 21, the copper disc electrodes 22 and 23 of two sheets face each other, and are arranged. A power source is connected to the up electrode 22 through a suitable impedance matching circuit using a 13.56Hz RF generator, and the lower electrode 23 is grounded. The inside of a reactor is first exhausted to 10-3torr, plasma CVD shuts an exhaust air bulb next, and it supplies a monomer steam until it is set to 10Torr(s) from inlet ports 24-0.1. The gas of an ethylene system is used as monomer gas. RF -- if suitable power is impressed to an electrode, the plasma polymerization film will accumulate in the order of 10 nm/min to 100 nm/min. As a parameter which governs a plasma polymerization reaction, there are a monomer quantity of gas flow, gas pressure, a discharge frequency, and discharge voltage. Although a plasma rate of polymerization generally rises with the increment in discharge voltage, by high tension, it is not based on discharge power but becomes fixed. Although drawing 2 showed the plasma-CVD equipment of a parallel plate form, as shown in drawing 3 , an ECR plasma CVD system can also be used. Such a method uses low-gas-pressure microwave discharge, its ionization rate improves figures triple [2-], and low temperature production and the improvement in membraneous are possible for it. If gas CH2F2 of an Freon system are especially used with an ECR plasma CVD system, the homogeneous good film will accumulate. Moreover, although the polymerization film which excites organic monomer gas by the low-temperature plasma (glow discharge), and is guided from the excitation monomer was deposited by the above-mentioned approach, in order to excite organic monomer gas, it can have far-ultraviolet light and vacuum-ultraviolet light, and can also be.
[0016] The detailed pattern formation approach of this invention is explained using drawing 1 using the plasma-CVD equipment constituted as mentioned above below.
[0017] At drawing 1 (a), the polish recon film 13 has deposited 0.5 microns on silicon substrate top 11 with intense surface irregularity in the separation oxide-film 12 grade.
[0018] drawing 1 (b) -- high -- using the plasma-CVD equipment mentioned above on the semi-conductor substrate which has reflection factor irregularity, the laminating of at least two or more kinds of multilayer acid-resisting thin films 14 and 15 is carried out, and they are deposited. The thickness of the acid-resisting thin films 14 and 15 and a refractive index are respectively set to d1, n1, d2, and n2. The reflection factor R of the two-layer film [as opposed to a substrate (refractive index: ns) this time] by which the laminating was carried out is the two-layer film Substrate (nS) -(n2, n2d2)-(n1, n1d1)- It is expressed with (several 1) when it is air (n0).
[0019]
[Equation 1]

$$R = X/(1+X)$$

$$X = n_s/4n_0\{[(n_0/n_s-1)\cos(g_1)\cos(g_2) + (n_1/n_2-n_0/n_s*n_2/n_1)\sin(g_1)\sin(g_2)]^2 + [(n_0/n_1-n_1/n_s)\cos(g_2)\sin(g_1) + (n_0/n_2-n_2/n_s)\cos(g_1)\sin(g_2)]^2\}$$

$$g_1 = 2\pi n_1 d_1/\lambda, g_2 = 2\pi n_2 d_2/\lambda$$

[0020] The combination of all the n1 and n2 that fill this time (several 2) serves as conditions of perfect acid resisting on specific wavelength.

[0021]

[Equation 2]

$$\tan^2(g_1) = n_1^2*(n_0-n_s)*(n_s n_0-n_2^2)/\{(n_s n_1-n_0 n_2^2)*(n_s n_0-n_1^2)\}$$

$$\tan^2(g_2) = n_2^2*(n_0-n_s)*(n_s n_0-n_1^2)/\{(n_s n_1-n_0 n_2^2)*(n_s n_0-n_2^2)\}$$

[0022] The spectral reflectance of a two-layer antireflection film is shown in drawing 4 . The two-layer antireflection film B (14 15) has the thickness which fills (several 2), and a refractive index. As for this two-layer antireflection film B, the spectral characteristic is loose to the antireflection film A of a monolayer. This means that the effectiveness of acid resisting does not fall steeply to film pressure fluctuation of an antireflection film simultaneously. Moreover, it becomes usable [the same antireflection film] also to two or more exposure wavelength by using the antireflection film which consisted of more than two-layer. In the example, CF4 gas of an Freon system was used as ethylene gas and gas for the 2nd layer thin film deposition as monomer gas for the 1st layer thin film deposition. Under the present circumstances, since the organic polymer thin film of the 2nd layer is the polymer of an Freon system, a refractive index will be able to fulfill acid-resisting conditions to 1.3 soon. Moreover, although the radical of an Freon system will etch Si as a substrate is Si, at this example, it is owner **** about multilayer structure as an antireflection film. Therefore, since Si substrate is protected by the organic monomer containing many carbon, the organic polymer which contained FOSO without etching Si substrate deposits it.

[0023] And in drawing 1 (c), the chemistry magnification mold resist 16 is applied on the reflective thin film 14 and 15, and a resist 16 is exposed with a KrF excimer aligner.

[0024] The reactant dry etching 18 which used the multilayer reflective film 14 and 15 with the TMAH solution in drawing 1 (d), and used the oxygen radical by drawing 1 (e) after development removes.

[0025] As mentioned above, in this example, a controllability can improve pattern formation, without being influenced by the echo from a substrate, even if it changes the antireflection film thickness 14 and 15 somewhat.

[0026] In addition, in this example, although dry etching removed the multilayer antireflection film 14 and 15, you may remove, irradiating far-ultraviolet light and vacuum-ultraviolet light in an ozone ambient atmosphere.

[0027] Moreover, although it is an example of a configuration about the antireflection film of the two-layer thin film with which refractive indexes differ in this example, in order to improve adhesion with the substrate of a thin film to deposit, it is also possible to carry out this

invention. Furthermore, although the multilayer antireflection film was removed on the same dry etching conditions at this example, you may remove on separate dry etching conditions.
[0028] (Example 2) It explains, referring to a drawing about the 2nd example of this invention below.
[0029] Drawing 5 is the block diagram showing the detailed pattern formation which shows the 2nd example of this invention. drawing 5 (a) -- high -- at least two or more kinds of organic polymer gas is introduced using the plasma-CVD equipment mentioned above on the semi-conductor substrate which has reflection factor irregularity, and the mixed deposition of the organic thin film 53 with polymer I (51) and Polymer II (52) is carried out.
[0030] And in drawing 5 (b), the chemistry magnification mold resist 16 is applied on this mixed thin film 53, and a resist 16 is exposed with a KrF excimer aligner.
[0031] At drawing 5 (c), the reactant dry etching which used the oxygen radical removes the mixed thin film 53 after development with a TMAH solution.
[0032] In this invention, it becomes possible by mixing SiH4, C2H2, helium gas, etc. as some kinds of monomer gas, and mixing and depositing a different thin film to deposit the antireflection film which has the refractive index of arbitration on a semi-conductor plate.
[0033] Moreover, although the mixed thin film was generated using the plasma-CVD equipment of a parallel plate mold in this example, in order to generate a mixed thin film, the same thing becomes possible, even if it irradiates an ion beam while depositing an organic thin film.
[0034] (Example 3) It explains, referring to a drawing about the 3rd example of this invention below.
[0035] Drawing 6 is the block diagram showing the detailed pattern formation which shows the 3rd example of this invention. drawing 6 (a) -- high -- the organic polymer acid-resisting thin film 61 is deposited in plasma CVD using the organic monomer (methyl methacrylate) gas which has photosensitivity to exposure light on the semi-conductor substrate which has reflection factor irregularity. And a resist 16 is applied on the reflective thin film 61, and a resist is exposed with a KrF excimer aligner. And a resist and a CVD antireflection film are simultaneously developed in a TMAH water solution (drawing 6 b and c).
[0036] In this example, although exposure development of a resist and the reflective thin film was carried out simultaneously, exposure development of the antireflection film may be carried out with the exposure light of different wavelength from the exposure light to the resist film, or you may remove.
[0037] Moreover, in this example, since the antireflection film deposited in plasma CVD has photosensitivity, it becomes possible [exposing the antireflection film of a wafer periphery with a wafer circumference exposure machine, developing it, and removing it].
[0038] (Example 4) It explains, referring to a drawing about the 4th example of this invention below.
[0039] Drawing 7 is the block diagram showing the detailed pattern formation which shows the 4th example of this invention. drawing 7 (a) -- high -- at least 1 microns or more of organic polymer acid-resisting thin films 71 which have photosensitivity are applied on a spin coat on the semi-conductor substrate which has reflection factor irregularity, and exposure development is carried out so that it may become the thickness of a request of the reflective thin film 71 (drawing 7 b and c).
[0040] Then, in drawing 7 (d), a resist 16 is applied on the antireflection film 71 which became the thickness of said request, and exposure development of the resist film 16 is carried out with exposure light (drawing 7 e and f).

[0041] By making it such a configuration, even if the level difference on a semi-conductor substrate is large, the organic antireflection film 71 can improve [homogeneity] a spin coat.
[0042] Moreover, it is small and the formation of a detailed pattern of the pattern shift at the time of removing an antireflection film by dry etching after the resist pattern formation on an antireflection film, since the organic antireflection film 71 is thin to desired thickness by exposure development after spreading is attained. In addition, in said example, although the organic antireflection film was thin-film-ized by exposure development, whole surface dry etching may be carried out so that it may become the thickness of a request of an acid-resisting thin film.
[0043]
[Effect of the Invention] above -- this invention -- high -- by depositing the acid-resisting thin film which has at least two or more kinds of refractive indexes in plasma CVD on the semi-conductor substrate which has reflection factor irregularity, applying a resist on said reflective thin film, and carrying out exposure development of said resist, even if thickness change of the acid-resisting thin film deposited on the semi-conductor substrate arises somewhat, sufficient acid-resisting effectiveness can be acquired, and a detailed pattern can be formed.

[Translation done.]

TECHNICAL FIELD

[Industrial Application] This invention relates to the formation approach of of the semiconductor device and integrated-circuit pattern using a photolithography to a semi-conductor substrate top with a high reflection factor.

[Translation done.]

PRIOR ART

[Description of the Prior Art] In recent years, pattern formation is performed in manufacture of semiconductor devices, such as IC and LSI, an electronic-circuitry component, etc. by the photolithography using ultraviolet rays. Although a raise in the numerical aperture of the projection lens of the aligner currently use in this photolithography, the activity of the source of short wave Nagamitsu, etc. be advance with detailed-izing of a component in recent years, and high integration, the problem of the standing wave effectiveness that the reflection factor from substrate-izing become high, and the effect of the standing wave in the inside of the resist film of exposure light become large, and fluctuation of a pattern dimension become large by it etc. arise. The energy accumulated by the cross protection of the light of an echo of the resist front face of exposure light and the echo from a substrate interface into the resist film is the thing of effectiveness which changes with minute change of resist thickness a lot, and the standing wave effectiveness is the phenomenon of changing a pattern dimension sharply by it.
[0003] Especially, these faults have the reflexibility remarkable in a high substrate over exposure light. For example, in the aluminum film and polish recon film which have irregularity in a substrate front face, the resist pattern itself becomes rickety by the scattered reflection from the substrate of exposure light. The approach using the resist containing a die which made the color which absorbs exposure light in a resist contain as an approach of controlling these faults, and the approach which has formed enough an antireflection film which absorbs exposure light on the substrate which has the high reflection factor which is a substrate, and carries out it were used. Moreover, the multilayer-resist process was proposed as other approaches.
[0004] The explanatory view of a three-layer resist is shown in drawing 8 . On the polish recon substrate which a reflection factor is high and has irregularity in a front face, it heat-treats by carrying out the 2-micron thickness spin coat of the poly membrane 81 which controls the reflected light from a substrate (this drawing a). Besides, 0.2-micron thickness formation of the inorganic polymer film 82, such as inorganic film of SiO2 grade or SOG (spin-on glass), is carried out as an interlayer. Furthermore, 0.5-micron thickness spreading of the photoresists, such as AZ micro POJITTO (Shipley), is carried out as an upper resist 83 on this, and a semiconductor integrated circuit pattern is exposed with a cutback projection aligner (this drawing b). Then, negatives are developed using an alkali water solution and the desired resist pattern 84 is formed (this drawing c). Next, a pattern imprint is performed more on the middle class 82 and the lower layer film 81 dirtily in a businesslike manner by using this resist pattern 84 as a mask (these drawings d and e). And pattern formation is carried out to the polish recon film 13 by dry etching using the pattern formed by doing in this way, and gate pattern formation is performed.
[0005] Since the lower layer film 81 which absorbs the reflected light from a substrate is formed

on a high reflective substrate like the polish recon 13 by using the above multilayers resist, a substrate echo is controlled and the exact upper pattern is obtained.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] above -- this invention -- high -- by depositing the acid-resisting thin film which has at least two or more kinds of refractive indexes in plasma CVD on the semi-conductor substrate which has reflection factor irregularity, applying a resist on said reflective thin film, and carrying out exposure development of said resist, even if thickness change of the acid-resisting thin film deposited on the semi-conductor substrate arises somewhat, sufficient acid-resisting effectiveness can be acquired, and a detailed pattern can be formed.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, although a three-layer resist process is an effective approach, its process is complicated and there are problems, such as fluctuation of a resist dimension, at the time of a pattern imprint. Moreover, a defect and dust generating become large and pose a big problem of yield lowering. Moreover, although an echo can be controlled by paying a color into a resist by the resist containing a die which made the color contain, since the incidence of exposure light will be barred simultaneously, there is a fault said that resolution deteriorates. Moreover, if pattern formation is performed on antireflection film which absorbs exposure light on the substrate which has a high reflection factor, it is dramatically difficult for the reflection factor from a substrate to fall, and for a taper to occur in the cross-section configuration of a resist pattern, to become a trapezoid or 3 angle configuration, and to obtain exact and detailed pattern formation. Furthermore, it had the trouble to say that the etching process of dedication was needed, the pattern shift at the time of etching became large, or the exfoliation process of an antireflection film was needed. If a level difference is furthermore on a substrate, antireflection film thickness will change locally. Therefore, the substrate reflection factor fluctuation accompanying thickness fluctuation arose, and there was a problem that a detailed pattern could not form in accuracy.
[0007] This invention offers the detailed pattern formation approach that sufficient acid-resisting effectiveness can be acquired, even if thickness change of the acid-resisting thin film deposited on the semi-conductor substrate arises somewhat in view of the above-mentioned trouble.

[Translation done.]

MEANS

[Means for Solving the Problem] in order to solve the above-mentioned trouble -- the detailed pattern formation approach of this invention, high -- at least two or more kinds of multilayer acid-resisting thin films are deposited in plasma CVD on the semi-conductor substrate which has reflection factor irregularity, a resist is applied on said reflective thin film, and a detailed pattern is formed by removing said multilayer reflective film for said resist by dry etching after exposure development.
[0009] furthermore, this invention -- high -- on the semi-conductor substrate which has reflection factor irregularity, the mixed deposition of the organic polymer which has at least two or more kinds of refractive indexes is carried out by plasma CVD, a resist is applied on the thin film, and a detailed pattern is formed more for said resist after exposure development that dry etching removes said mixed antireflection film.
[0010] furthermore, this invention -- high -- the acid-resisting thin film which also has photosensitivity to exposure light is deposited in plasma CVD on the semi-conductor substrate which has reflection factor irregularity, a resist is applied on said reflective thin film, and a detailed pattern is formed by developing said resist and a CVD antireflection film simultaneously.

[0011] furthermore, this invention -- high -- the acid-resisting thin film which has photosensitivity is deposited in plasma CVD on the semi-conductor substrate which has reflection factor irregularity, a resist is applied on said reflective thin film, and a detailed pattern is formed by carrying out exposure development of the antireflection film with the exposure light of wavelength which is different from the exposure light to said resist film after exposure development with exposure light in said resist film.
[0012] furthermore, this invention -- high -- at least 1 microns or more of organic polymer acid-resisting thin films which have photosensitivity are applied on a spin coat on the semi-conductor substrate which has reflection factor irregularity, a resist is applied after exposure development on the antireflection film which became the thickness of said request so that it may become the thickness of a request of said reflective thin film, and it has the configuration which carries out exposure development of said resist film with exposure light and to say.

[Translation done.]

OPERATION

[Function] By the above-mentioned configuration, this invention can acquire sufficient acid-resisting effectiveness, even if thickness change of the acid-resisting thin film deposited on the semi-conductor substrate arises somewhat, and as a result, it can form a detailed pattern with a sufficient controllability.

[Translation done.]

EXAMPLE

[Example]
(Example 1) The detailed pattern formation approach of the 1st example of this invention is explained below, referring to a drawing.
[0015] Drawing 2 shows the outline of the plasma-CVD equipment used for deposition of the acid-resisting thin film used by this example. In in the glass bell jar 21, the copper disc electrodes 22 and 23 of two sheets face each other, and are arranged. A power source is connected to the up electrode 22 through a suitable impedance matching circuit using a 13.56Hz RF generator, and the lower electrode 23 is grounded. The inside of a reactor is first exhausted to 10-3torr, plasma CVD shuts an exhaust air bulb next, and it supplies a monomer steam until it is set to 10Torr(s) from inlet ports 24-0.1. The gas of an ethylene system is used as monomer gas. RF -- if suitable power is impressed to an electrode, the plasma polymerization film will accumulate in the order of 10 nm/min to 100 nm/min. As a parameter which governs a plasma polymerization reaction, there are a monomer quantity of gas flow, gas pressure, a discharge frequency, and discharge voltage. Although a plasma rate of polymerization generally rises with the increment in discharge voltage, by high tension, it is not based on discharge power but becomes fixed. Although drawing 2 showed the plasma-CVD equipment of a parallel plate form, as shown in drawing 3 , an ECR plasma CVD system can also be used. Such a method uses low-gas-pressure microwave discharge, its ionization rate improves figures triple [2-], and low temperature production and the improvement in membraneous are possible for it. If gas CH2F2 of an Freon system are especially used with an ECR plasma CVD system, the homogeneous good film will accumulate. Moreover, although the polymerization film which excites organic monomer gas by the low-temperature plasma (glow discharge), and is guided from the excitation monomer was deposited by the above-mentioned approach, in order to excite organic monomer gas, it can have far-ultraviolet light and vacuum-ultraviolet light, and can also be.
[0016] The detailed pattern formation approach of this invention is explained using drawing 1 using the plasma-CVD equipment constituted as mentioned above below.
[0017] At drawing 1 (a), the polish recon film 13 has deposited 0.5 microns on silicon substrate top 11 with intense surface irregularity in the separation oxide-film 12 grade.
[0018] drawing 1 (b) -- high -- using the plasma-CVD equipment mentioned above on the semi-conductor substrate which has reflection factor irregularity, the laminating of at least two or more kinds of multilayer acid-resisting thin films 14 and 15 is carried out, and they are deposited. The thickness of the acid-resisting thin films 14 and 15 and a refractive index are respectively set to d1, n1, d2, and n2. The reflection factor R of the two-layer film [as opposed to a substrate (refractive index: ns) this time] by which the laminating was carried out is the

two-layer film Substrate (nS) -(n2, n2d2)-(n1, n1d1)- It is expressed with (several 1) when it is air (n0).

[0019]

[Equation 1]

$$R=X/(1+X)$$

$$X=n_s/4n_0\{[(n_0/n_s-1)\cos(g_1)\cos(g_2)+(n_1/n_2-n_0/n_s*n_2/n_1)\sin(g_1)\sin(g_2)]^2+[(n_0/n_1-n_1/n_s)\cos(g_2)\sin(g_1)+(n_0/n_2-n_2/n_s)\cos(g_1)\sin(g_2)]^2\}$$

$$g_1=2\pi n_1d_1/\lambda,\ g_2=2\pi n_2d_2/\lambda$$

[0020] The combination of all the n1 and n2 that fill this time (several 2) serves as conditions of perfect acid resisting on specific wavelength.

[0021]

[Equation 2]

$$\tan^2(g_1)=n_1^2*(n_0-n_s)*(n_sn_0-n_2^2)/\{(n_sn_1-n_0n_2^2)*(n_sn_0-n_1^2)\}$$

$$\tan^2(g_2)=n_2^2*(n_0-n_s)*(n_sn_0-n_1^2)/\{(n_sn_1-n_0n_2^2)*(n_sn_0-n_2^2)\}$$

[0022] The spectral reflectance of a two-layer antireflection film is shown in drawing 4 . The two-layer antireflection film B (14 15) has the thickness which fills (several 2), and a refractive index. As for this two-layer antireflection film B, the spectral characteristic is loose to the antireflection film A of a monolayer. This means that the effectiveness of acid resisting does not fall steeply to film pressure fluctuation of an antireflection film simultaneously. Moreover, it becomes usable [the same antireflection film] also to two or more exposure wavelength by using the antireflection film which consisted of more than two-layer. In the example, CF4 gas of an Freon system was used as ethylene gas and gas for the 2nd layer thin film deposition as monomer gas for the 1st layer thin film deposition. Under the present circumstances, since the organic polymer thin film of the 2nd layer is the polymer of an Freon system, a refractive index will be able to fulfill acid-resisting conditions to 1.3 soon. Moreover, although the radical of an Freon system will etch Si as a substrate is Si, at this example, it is owner **** about multilayer structure as an antireflection film. Therefore, since Si substrate is protected by the organic monomer containing many carbon, the organic polymer which contained FOSO without etching Si substrate deposits it.

[0023] And in drawing 1 (c), the chemistry magnification mold resist 16 is applied on the reflective thin film 14 and 15, and a resist 16 is exposed with a KrF excimer aligner.

[0024] The reactant dry etching 18 which used the multilayer reflective film 14 and 15 with the TMAH solution in drawing 1 (d), and used the oxygen radical by drawing 1 (e) after development removes.

[0025] As mentioned above, in this example, a controllability can improve pattern formation, without being influenced by the echo from a substrate, even if it changes the antireflection film thickness 14 and 15 somewhat.

[0026] In addition, in this example, although dry etching removed the multilayer antireflection film 14 and 15, you may remove, irradiating far-ultraviolet light and vacuum-ultraviolet light in an

ozone ambient atmosphere.
[0027] Moreover, although it is an example of a configuration about the antireflection film of the two-layer thin film with which refractive indexes differ in this example, in order to improve adhesion with the substrate of a thin film to deposit, it is also possible to carry out this invention. Furthermore, although the multilayer antireflection film was removed on the same dry etching conditions at this example, you may remove on separate dry etching conditions.
[0028] (Example 2) It explains, referring to a drawing about the 2nd example of this invention below.
[0029] Drawing 5 is the block diagram showing the detailed pattern formation which shows the 2nd example of this invention. drawing 5 (a) -- high -- at least two or more kinds of organic polymer gas is introduced using the plasma-CVD equipment mentioned above on the semi-conductor substrate which has reflection factor irregularity, and the mixed deposition of the organic thin film 53 with polymer I (51) and Polymer II (52) is carried out.
[0030] And in drawing 5 (b), the chemistry magnification mold resist 16 is applied on this mixed thin film 53, and a resist 16 is exposed with a KrF excimer aligner.
[0031] At drawing 5 (c), the reactant dry etching which used the oxygen radical removes the mixed thin film 53 after development with a TMAH solution.
[0032] In this invention, it becomes possible by mixing SiH4, C2H2, helium gas, etc. as some kinds of monomer gas, and mixing and depositing a different thin film to deposit the antireflection film which has the refractive index of arbitration on a semi-conductor plate.
[0033] Moreover, although the mixed thin film was generated using the plasma-CVD equipment of a parallel plate mold in this example, in order to generate a mixed thin film, the same thing becomes possible, even if it irradiates an ion beam while depositing an organic thin film.
[0034] (Example 3) It explains, referring to a drawing about the 3rd example of this invention below.
[0035] Drawing 6 is the block diagram showing the detailed pattern formation which shows the 3rd example of this invention. drawing 6 (a) -- high -- the organic polymer acid-resisting thin film 61 is deposited in plasma CVD using the organic monomer (methyl methacrylate) gas which has photosensitivity to exposure light on the semi-conductor substrate which has reflection factor irregularity. And a resist 16 is applied on the reflective thin film 61, and a resist is exposed with a KrF excimer aligner. And a resist and a CVD antireflection film are simultaneously developed in a TMAH water solution (drawing 6 b and c).
[0036] In this example, although exposure development of a resist and the reflective thin film was carried out simultaneously, exposure development of the antireflection film may be carried out with the exposure light of different wavelength from the exposure light to the resist film, or you may remove.
[0037]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Detailed pattern formation process drawing using the multilayer antireflection film in the 1st example of this invention
[Drawing 2] The block diagram of the plasma-CVD equipment which can carry out this invention
[Drawing 3] The block diagram of the CVD system of ECR which can carry out this invention
[Drawing 4] Property drawing showing the spectral reflectance at the time of using a multilayer antireflection film
[Drawing 5] Detailed pattern formation process drawing using the antireflection film which consisted of mixed organic polymers in the 2nd example of this invention
[Drawing 6] Detailed pattern formation process drawing using the multilayer antireflection film deposited in the plasma CVD which has the photosensitivity in the 3rd example of this invention
[Drawing 7] Process drawing of the detailed pattern formation at the time of using the antireflection film of the thick film in the 4th example of this invention
[Drawing 8] Detailed pattern formation process drawing of the conventional three-layer resist process
[Description of Notations]
11 Silicon Substrate
13 Polish Recon Film
14 Antireflection Film of 1st Layer
15 Antireflection Film of 2nd Layer
16 Chemistry Magnification Mold Resist
18 Reactivity RIE

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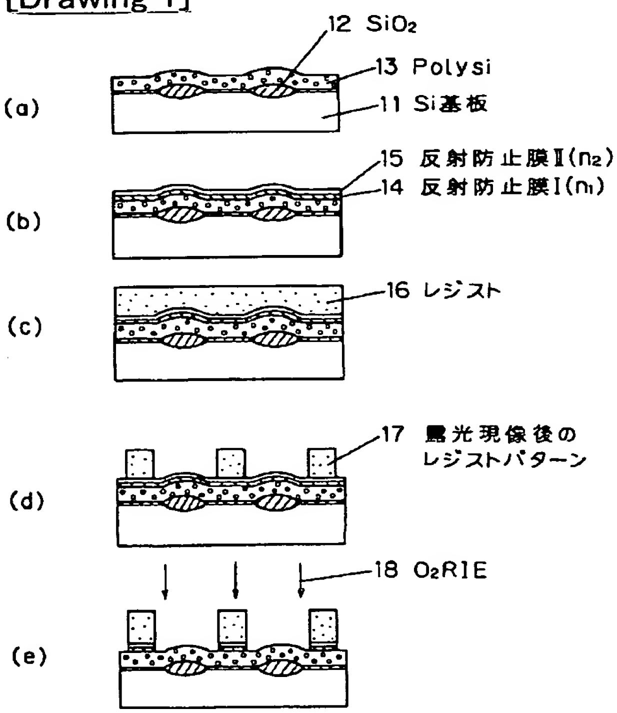
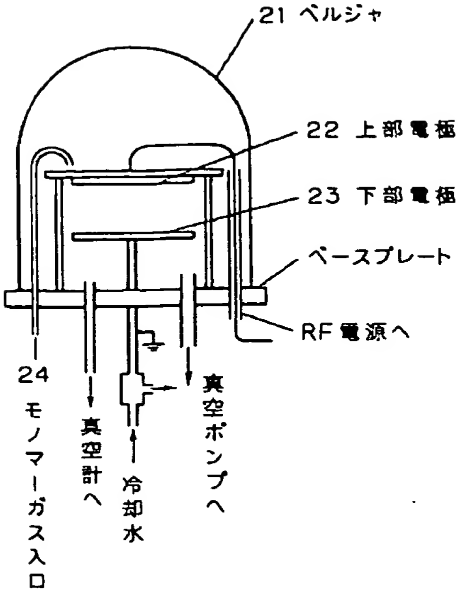
DRAWINGS

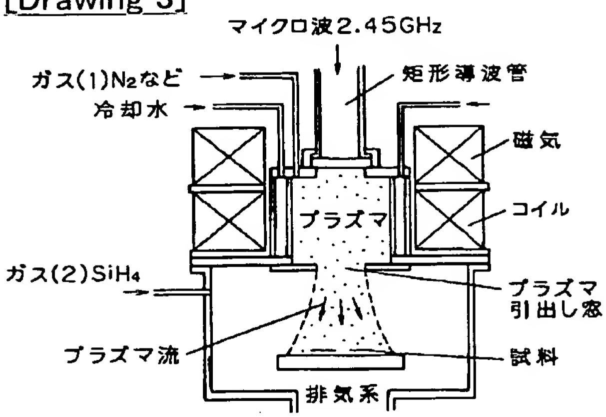
[Drawing 1]



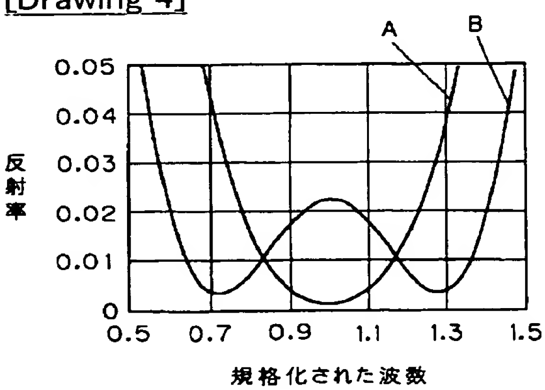
[Drawing 2]



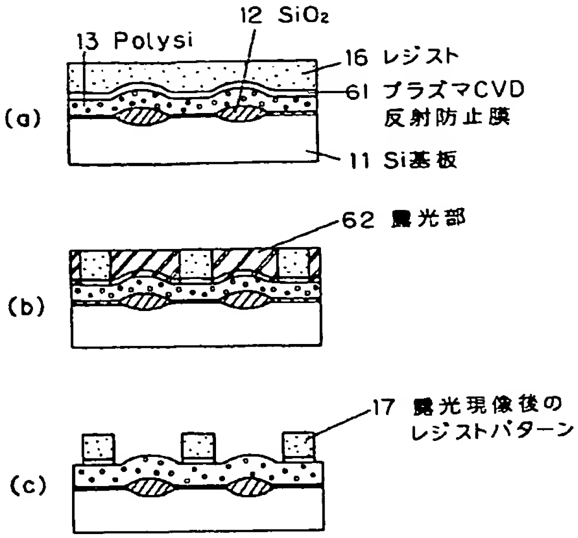
[Drawing 3]



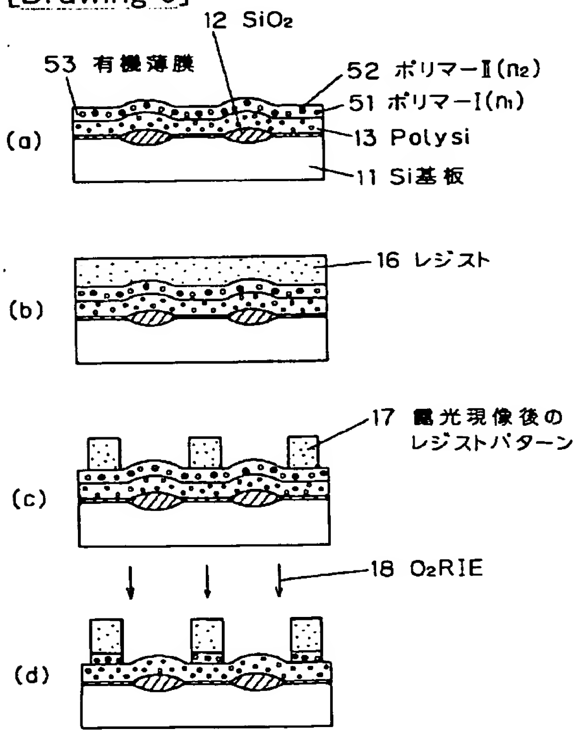
[Drawing 4]



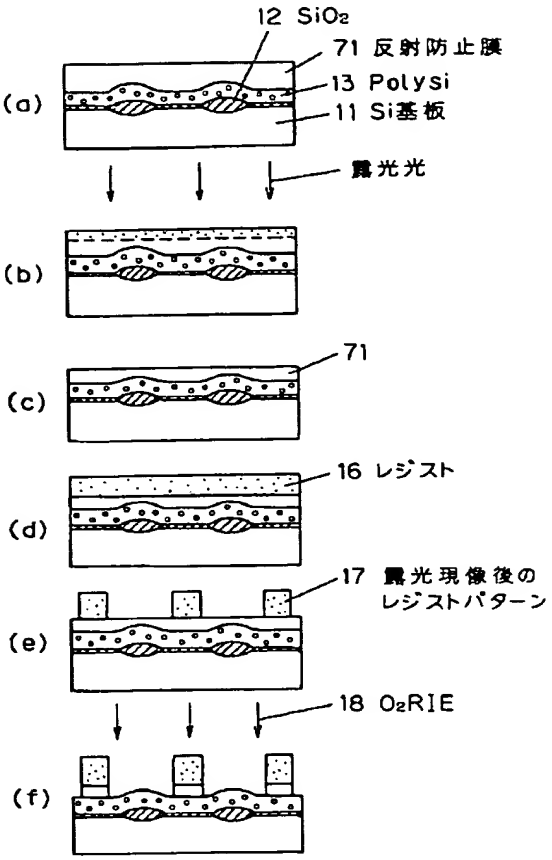
[Drawing 6]



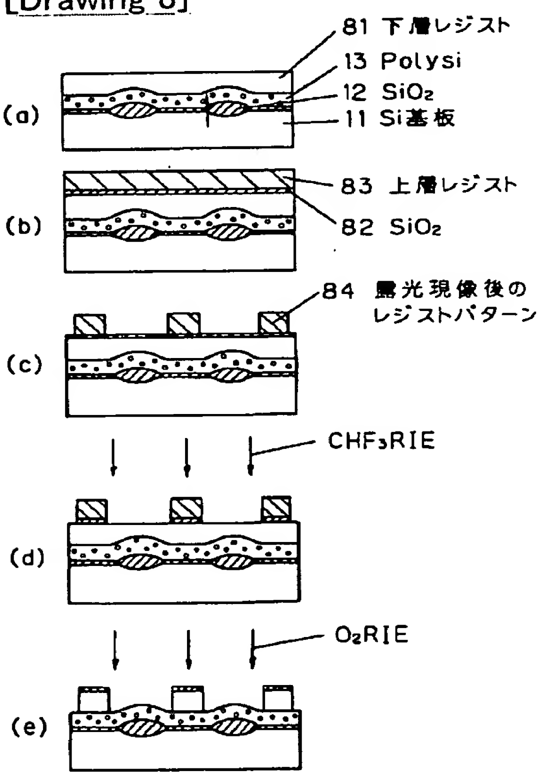
[Drawing 5]



[Drawing 7]



[Drawing 8]



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